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# Software Engineering Design & Construction

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Template Method Pattern

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# The Template-Method Pattern in a Nutshell

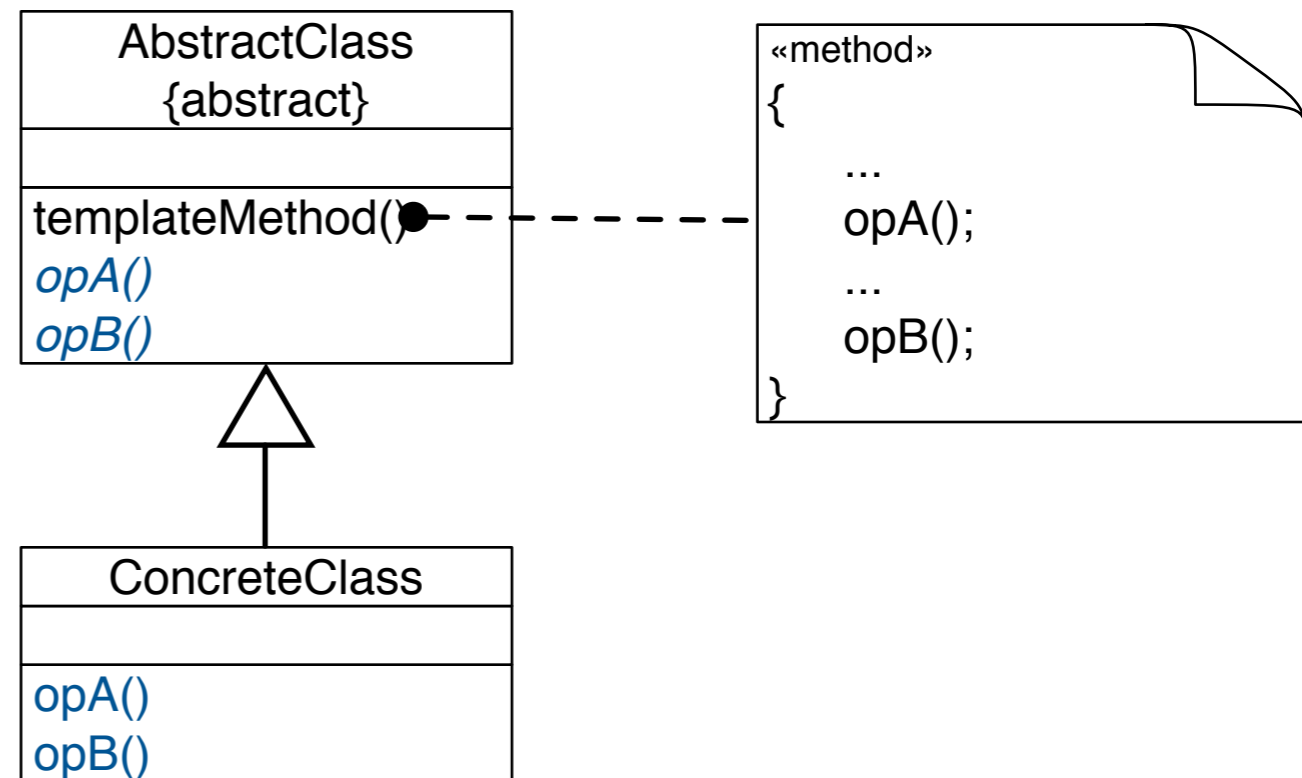
## Intent:

- Separate high-level policies from detailed low-level mechanisms.
- **Separate invariant from variant parts.**

## Solution Idea:

Use abstract classes to:

- Define interfaces to detailed mechanisms and variant parts.
- Implement high-level policies and invariant parts to these interfaces.
- Control sub-class extensions.
- Avoid code duplication.



# Example Application of Template Method

## **Functional requirements:**

- Need a family of sorting algorithms ...(bubble sort, quick sort, etc.)
- for different kinds of data (int, double, etc.)
- Clients that use sorting algorithms should be reusable with a variety of specific algorithms.

## **Non-functional requirements on the design:**

- Need to separate the high-level „sorting“ policies from low-level mechanisms.
- Low-level mechanisms are responsible for:
  - deciding when an element is out of order,
  - swapping out-of-order elements.

# Separating the Policy of Sorting

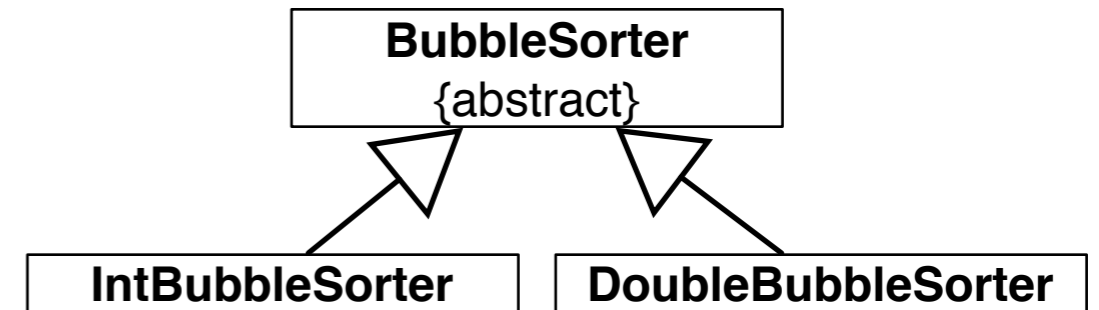
```
public abstract class BubbleSorter {  
    protected int length = 0;
```

## Policy

```
protected void sort() {  
    if (length <= 1) return;  
    for (int nextToLast = length - 2; nextToLast >= 0; nextToLast--)  
        for (int index = 0; index <= nextToLast; index++)  
            if (outOfOrder(index)) swap(index);  
}
```

## Mechanism

```
protected abstract void swap(int index);  
protected abstract boolean outOfOrder(int index);  
}
```

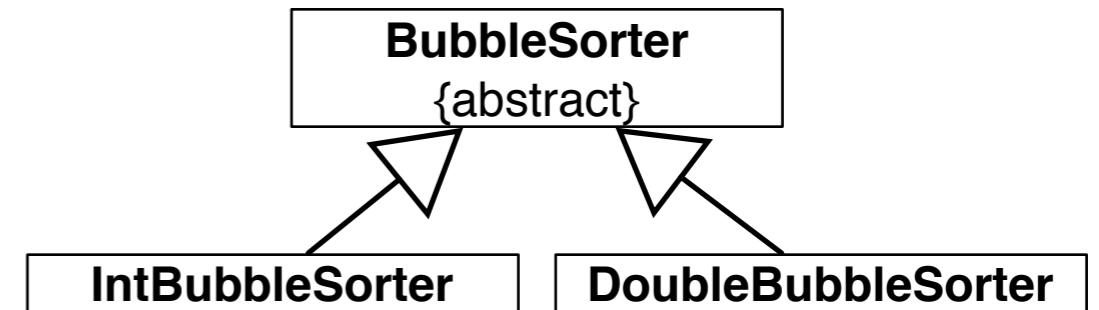


# Filling the Template for Specific Algorithms

```
public class IntBubbleSorter
    extends BubbleSorter {

    private int[] array = null;

    public void sort(int[] theArray) {
        array = theArray;
        length = array.length;
        /*"super"*/sort();
    }
    protected void swap(int index) {
        int temp = array[index];
        array[index] = array[index + 1];
        array[index + 1] = temp;
    }
    protected boolean outOfOrder(int index) {
        return (array[index] > array[index + 1]);
    }
}
```



What are the advantages and deficiencies of the Template-Method Pattern?

# Task: Identify the *Template Method Pattern* in *Log4J*

## interface Appender

Implement this interface for your own strategies for outputting log statements. [...]

```
public void doAppend(LoggingEvent event)
```

Log in Appender specific way.

## abstract class AppenderSkeleton implements Appender

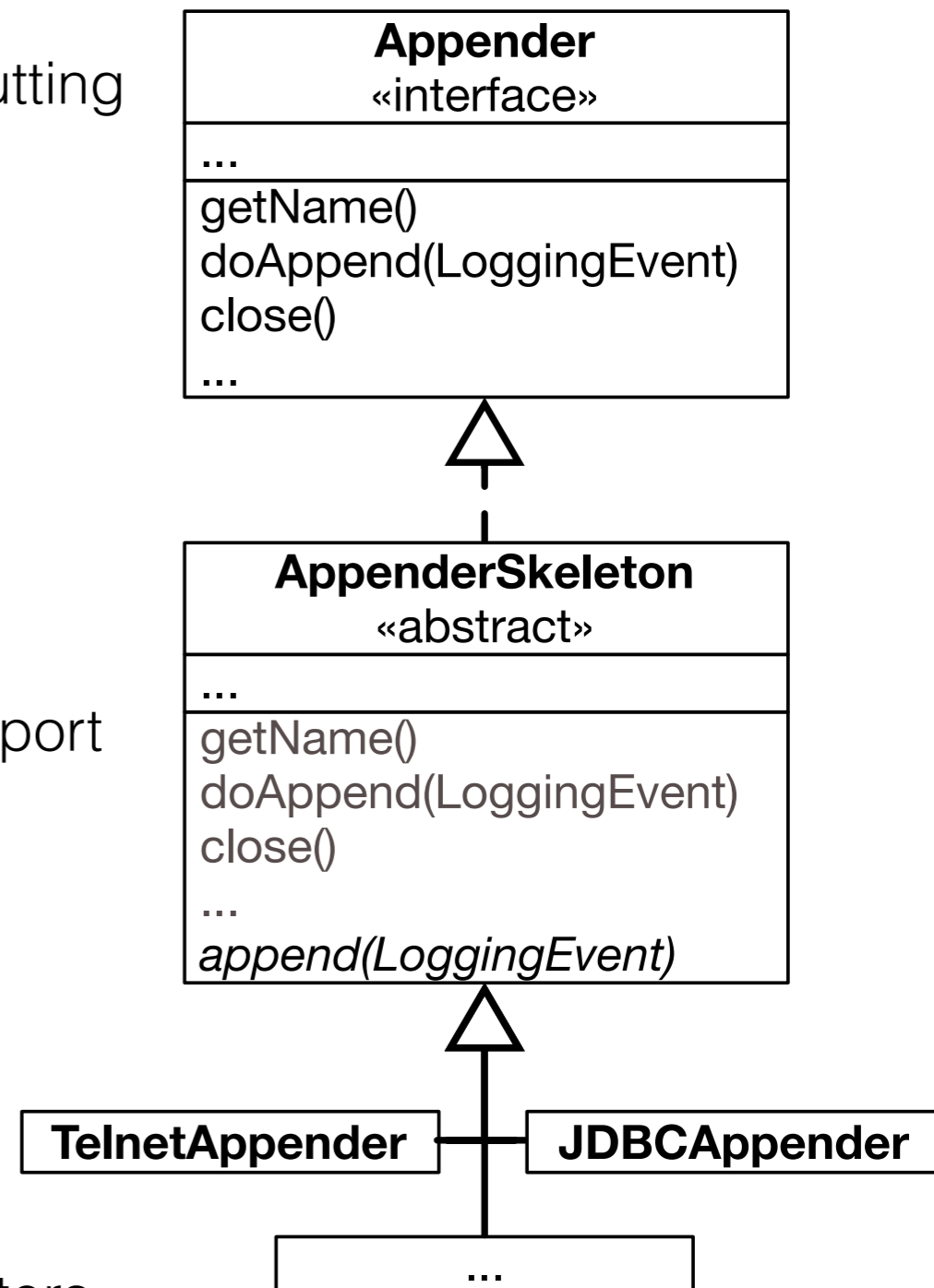
Abstract superclass of the other appenders. This class provides the code for common functionality, such as support for threshold filtering and support for general filters. [...]

```
abstract void append(LoggingEvent event)
```

Subclasses should implement this method to perform actual logging.

```
void doAppend(LoggingEvent event)
```

This method performs threshold checks and invokes filters before delegating actual logging to the `append(LoggingEvent)` method.



# Functional Counterpart of Template

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One can look at the Template-Method Pattern as a style for emulating higher-order functions available in programming languages that support functional-style programming.

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Alternative design for Log4J in Scala?

```
class AppenderSkeleton(  
  private val append : (LoggingEvent) => Unit // Function1[LoggingEvent,Unit]  
) {  
  def doAppend(loggingEvent : LoggingEvent) {  
    // filtering, threshold checks,...  
    append(loggingEvent)  
  }  
}
```

# Scala (2.11.x) HashTable

```
/**  
[...]  
There are mainly two parameters that affect the performance of a hashtable: the initial size  
and the load factor. The size refers to the number of buckets in the hashtable, and the load  
factor is a measure of how full the hashtable is allowed to get before its size is  
automatically doubled. Both parameters may be changed by overriding the corresponding  
values in class HashTable.  
*/  
trait HashTable[A, Entry >: Null <: HashEntry[A, Entry]] extends HashTable.HashUtils[A] {  
  [...]  
  /** The actual hash table.*/  
  @transient protected var table: Array[HashEntry[A, Entry]] = new Array(initialCapacity)  
  
  /** The initial size of the hash table.*/  
  protected def initialSize: Int = 16  
  
  private def initialCapacity = capacity(initialSize)  
  
  [...]  
}
```